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Unharvested Fishes in the U.S. Commercial Fishery of Western Lake Erie in 1969

HARRY D. VAN METER

SEATTLE, WA
JULY 1973

National Marine Fisheries Service, Special Scientific Report--Fisheries Series

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Unharvested Fishes in the U.S. Commercial Fishery of Western Lake Erie in 1969[1]

HARRY D. VAN METER[2]

ABSTRACT

Potential commercial fish production was estimated for U.S. waters of western Lake Erie in 1969 from pounds landed and pounds discarded. Periodic observations of catches in haul seines and trap nets revealed that about 37% of the catch (by weight) in haul seines and 26% of that in trap nets were low-value fishes that were discarded. Projection of these discarded catches to include the total fishing effort indicated that an additional 2.8 million lb of low-value species would have been landed in 1969 if a reasonable profit had been assurred. It is concluded that the sustained yield could be increased considerably with only a moderate increase in fishing effort.

INTRODUCTION

A sizable percentage of the U.S. commercial fish catch in western Lake Erie is discarded and returned to the lake each year because market demand is lacking or the profit margin is too small. As early as 1955, the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) investigated new markets for underutilized fish from Lake Erie (Premetz, 1956). Emphasis in earlier years was on the development of markets in the fur farm and pet food industries as outlets for such low-value species as freshwater drum (*Aplodinotus grunniens*), gizzard shad (*Dorosoma cepedianum*), carp (*Cyprinus carpio*), and goldfish (*Carassius auratus*)[3]. Recently, certain commercial interests have explored the possibility of using these fish for fish meal and other industrial products.

Greater market expansion is not the real crux of the problem confronting the fishermen today. Rather, there is a need to develop low-cost methods of harvesting and processing the less desirable species in sufficient volume to provide a competitive product in existing markets.

A questionnaire survey in the 1950's revealed that Ohio commercial fishermen believed that the potential annual production of low-value species was more than 25 million lb. They estimated that 15 million lb were available in Sandusky Bay alone (Jones, 1960). These figures are still quoted by fishermen and biologists, in the absence of specific data on population densities of Lake Erie fishes.

In 1969 I attempted to determine the magnitude and species composition of the discarded portion of the U.S. catch from the principal gears employed in the western basin of Lake Erie. Data were collected on landed and discarded catches from 14 seine hauls in Sandusky Bay and 226 trap net lifts off Bono and Sandusky, Ohio. Catch data were then compared with the 1969 commercial production from the western basin and projected to estimate the potential take of these unharvested fish and the loss of revenue through lack of market demand or a suitable profit margin.

Several Lake Erie species, including walleye (*Stizostedion vitreum vitreum*), yellow perch (*Perca flavescens*), white bass (*Morone chrysops*), and channel catfish (*Ictalurus punctatus*), are taken by both the commercial and sport fisheries in the western basin. Other select species sometimes caught by commercial gear are classi-

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[3] Common and scientific names of fishes mentioned in the text are those adopted by Bailey (1970).

Figure 1.—Lake Erie is morphometrically separated into three basins. The small, shallow western basin shown here has a surface area of about 1,300 square miles. For compiling commercial production, the basin is divided into fishery statistical districts. Canadian waters are represented by district OE-1; Ohio waters by districts 0-1 (open lake), 0-4 (Sandusky Bay), and 0-5 (inland tributary waters); and Michigan waters by a single district.

fied as game and panfish and are excluded from the commercial harvest; these include primarily coho salmon (*Oncorhynchus kisutch*), smallmouth bass (*Micropterus dolomieui*), rock bass (*Ambloplites rupestris*), black crappie (*Pomoxis nigromaculatus*), white crappie (*Pomoxis annularis*), bluegill (*Lepomis macrochirus*), green sunfish (*Lepomis cyanellus*), and pumpkinseed (*Lepomis gibbosus*). These fish, which were counted and weighed but omitted from the catch estimates in the present study, made up less than 0.2% of the total weight of all fish caught in the seine hauls and trap net lifts observed.

THE COMMERCIAL FISHERY

The western basin of Lake Erie has long been considered to have the most valuable spawning and nursery grounds in the entire lake (Langlois, 1954). It makes up only 13% of the lake area and has an average depth of less than 25 ft (Fig. 1). The comparatively warm waters of this basin, together with the extensive shoal areas around the many islands, provide ideal fishing grounds for many species of fish. However, the long-term effects of environmental degradation, heavy exploitation, and the introduction of new species—*e.g.*, carp, goldfish, and rainbow smelt (*Osmerus mordax*)—have greatly changed the composition of the catch through the years (Applegate and Van Meter, 1970).

Historically, the fishery has depended on such high-value fishes as the cisco (*Coregonus artedii*), lake whitefish (*Coregonus clupeaformis*), blue pike (*Stizostedion vitreum glaucum*), and walleye. Of these, only the walleye is of commercial importance in Lake Erie today, and it is in jeopardy. Since 1957 successful hatches have been produced in the western basin at only 3- or 4-year intervals, and the year classes have been heavily fished before they reached maturity. The result has been an all-time low in production and standing crop. Even with more stringent regulations today, the walleye faces a struggle for survival because of deteriorating environmental conditions in the lake.

The year-class success of medium-value fishes —yellow perch, white bass, and channel catfish —is also fluctuating more widely from year to year than in the 1950's. The immediate future of the yellow perch, the mainstay of Lake Erie production for the past decade, is of major concern despite record landings in 1969. In effect, a majority of the year's production was comprised of the exceptionally strong 1965 year class of perch that is about to phase out of the fishery. Landings in 1970 declined sharply and future landings are expected to continue this downward trend until another strong year class is produced.

On the other hand, several low-value species have flourished and are greatly underexploited because the profit margin is small and the market demand unsteady. Few low-value fish are sold in the retail fresh-fish market although certain low-value species bring as much as 6¢ per pound to the haul seiners when sold alive to pond owners who charge a fee for fishing. This market, however, is largely restricted to the spring season because fish mortalities during holding and transport are prohibitively high in warm weather. Although most low-value species can be sold as mink and pet food at 2¢ per pound, the fishermen are unable to show a profit at this price. Consequently, many tons are discarded and returned to the water. Freshwater drum, carp,

Figure 2.—A typical trap net lift in U.S. waters of the western basin. Depth of trap net opening may range from 10 to 30 ft.

Figure 3.—A haul seine, about 1,200 yd long, being brought ashore. This net is set in a semicircle off of barge towed by a boat.

and goldfish, for example, are landed only at times when more valuable species are not being caught. In fact, fishermen often relocate their nets or stop fishing entirely in areas where the less desirable species are abundant.

The main types of fishing gear currently employed in western Lake Erie are gill nets in Canadian waters, and trap nets (in the open lake) (Fig. 2) and haul seines (Figs. 3 and 4) (in the shallower shoreline and bay areas) in U.S. waters. Stringent regulations in recent years have practically eliminated the use of gill nets in U.S. waters of western Lake Erie.

Of great importance to the fishery of the western basin is shallow Sandusky Bay, located between the mouth of the Sandusky River and the open lake (Fig. 1). It is about 15 miles long and averages about three miles wide, has an area of about 36,000 acres, and averages 6 to 8 ft deep. Although fish can move freely between the lake and bay, haul seines, which are the major gear used in the bay, take a higher proportion of low-value fishes throughout the year than are taken by either haul seines or trap nets in the lake.

COMMERCIAL LANDINGS IN 1969

The commercial yield for all of Lake Erie in 1969 was over 59 million lb (Table 1), or about 10 million lb higher than the average for 1913-68 (Baldwin and Saalfeld, 1962, plus supplement, 1970). The 1969 Canadian landings reached a record high of 48 million lb (about 81% of the total lake harvest) compared with U.S. landings of 11 million lb (19%)[4]. Ohio fishermen harvested about 9.5 million lb, or 86% of the U.S. total and 16% of the lakewide catch.

Figure 4.—Bagging the haul seine for removal of the catch. Frequently most of the catch is discarded.

The 1969 commercial landings in the western basin totaled some 16.4 million lb or nearly 28% of the lakewide catch (Table 2); Ontario contributed about 50%, Ohio 46%, and Michigan 4%. Sandusky Bay, which makes up less than 4% of the area of the western basin, accounted

[4] The 1969 statistics were obtained directly from the several State and Provincial agencies that administer the Lake Erie fishery.

Table 1.—Total fish yield (pounds) from Lake Erie in 1969.

Category, and species	Michigan	Ohio	Pennsylvania	New York	Total, United States	Canada	Lake total
High value							
Walleye	47,161	139,302	4,793	91,304	282,560	192,591	475,151
Whitefish, cisco	3	746	147	8	904	1,417	2,321
Others[1]	2		9	29	40	1,549	1,589
Medium value							
Yellow perch	111,815	2,660,536	479,446	112,709	3,364,506	29,801,833	33,166,339
White bass	57,213	1,155,867	2,563	3,043	1,218,686	874,840	2,093,526
Channel catfish	21,144	713,465	744	673	736,026	101,513	837,539
Others[1]				1,003	1,003	98,840	99,843
Low value							
Freshwater drum	39,885	1,992,877	2,992	24,532	2,060,286	339,377	2,399,663
Bullheads	472	35,030	32	2	35,536	19,448	54,984
Rainbow smelt		464	1,399	310	2,173	15,075,522	15,077,695
Buffalo, quillback	9,151	46,544			55,695		55,695
Carp	431,785	2,586,849	788	351	3,019,773	189,531	3,209,304
Goldfish, carp X goldfish		98,912			98,912		98,912
White sucker, redhorse	25,374	110,200	3,876	33,272	172,722	16,317	189,039
Others[1]		77		625	702	21,449	22,151
Mixed scrap[2]						1,291,769	1,291,769
Total all species	744,005	9,540,869	496,789	267,861	11,049,524	48,025,996	59,075,520

[1] Others: high value—blue pike, northern pike, sturgeon, sauger; medium value—rock bass, crappies and other panfishes; low value—mooneye, burbot, American eel, bowfin.

[2] Unidentified (most were reportedly freshwater drum).

Table 2.—Total fish yield (pounds) from the western basin of Lake Erie in 1969.

Category, and species	Michigan	Ohio (Districts O-1, O-4, O-5)	Total, United States	Canadian waters (District OE-1)	Total western basin
High value					
Walleye	47,161	132,766	179,927	165,208	345,135
Whitefish, cisco	3	485	488	425	913
Others[1]	2		2	383	385
Medium value					
Yellow perch	111,815	921,641	1,033,456	6,640,111	7,673,567
White bass	57,213	1,058,626	1,115,839	685,110	1,800,949
Channel catfish	21,144	695,994	717,138	74,597	791,735
Others[1]				185	185
Low value					
Freshwater drum	39,885	1,854,367	1,894,252	30,595	1,924,847
Bullheads	472	34,864	35,336		35,336
Rainbow smelt		209	209	12,419	12,628
Buffalo, quillback	9,151	46,241	55,392		55,392
Carp	431,785	2,559,486	2,991,271	81,192	3,072,463
Goldfish, carp X goldfish		98,912	98,912		98,912
White sucker, redhorse	25,374	86,503	111,877	3,550	115,427
Others[1]		32	32		32
Mixed scrap[2]				519,185	519,185
Total all species	744,005	7,490,126	8,234,131	8,212,960	16,447,091

[1] Others: high value—blue pike, northern pike, sturgeon, sauger; medium value—rock bass, crappies and other panfishes; low value—mooneye, burbot, American eel, bowfin.

[2] Unidentified (most were reportedly freshwater drum).

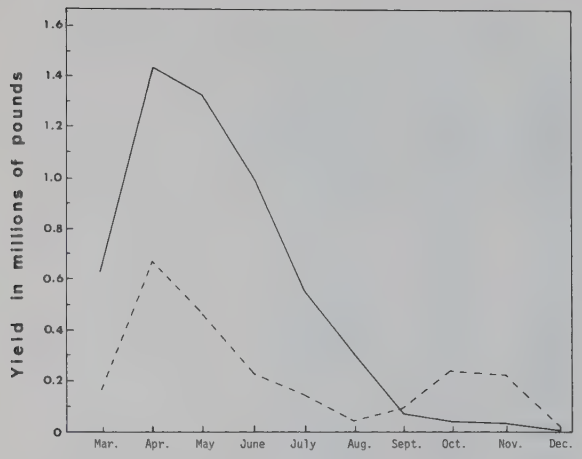

Figure 5.—Total fish yield by months in U.S. waters of the western basin for haul seines (solid line) and trap nets (broken line) in 1969. No fish were taken in January and February.

for more than 20% of the total landings. Since the late 1940's the bay has been the most heavily fished district in Ohio, if not in the entire lake. In 1948-53, Sandusky Bay fishermen landed an average of 58.5 lb of fish per acre, compared with an average of 9.1 lb per acre for other Ohio waters of Lake Erie (Chapman, 1955). In 1969, Sandusky Bay yielded 95.4 lb of fish per acre, compared with an average of 2.7 lb for Ohio waters of the open lake. The entire western basin yielded an average of 19.8 lb per acre and the entire lake about 9.3 lb per acre.

At least seven types of commercial gear were fished in the western basin of Lake Erie in 1969 (Table 3). Three types, however, accounted for 92% of the fish produced: Small-mesh gill nets took over 6.9 million lb, haul seines 5.7 million, and trap nets 2.5 million.

Although regulations that govern the fishing seasons vary among the states and the Province of Ontario, fishing normally begins in late March and ends about mid-December, depending on ice conditions. The fishing season in the Ohio waters of Lake Erie is administratively separated into a spring and a fall fishery. The haul seine fishery produced over 68% of the U.S. catch in the western basin in 1969 and the trap net fishery nearly 30%. Production in the seine fishery was highest during late April and early May, and steadily declined as the season progressed (Fig. 5). Production in the trap net fishery was also highest in April and May; after a summer lull, it increased again in the fall.

ESTIMATED CATCHES BY HAUL SEINES AND TRAP NETS

Commercial fishermen remove their catch from haul seines and trap nets with long-handled dip nets (an average of 20 to 30 lb of fish are taken per dip). The fish are quickly sorted after each dip and unwanted fish returned to the water. Fish to be kept are separated according to species and boxed, or placed in holding pens if destined for the live-fish market.

During trips to the fishing grounds, observers estimated the weight of the fish taken in each dip of the net and kept a running tally of total

Table 3.—Total fish yield (pounds) by gear from the western basin of Lake Erie in 1969.

Gear	United States		Canada		Total	
	Pounds	%	Pounds	%	Pounds	%
Small-mesh gill net	4,299	Tr[1/]	6,906,041	84	6,910,340	42
Haul seine	5,609,172	68	103,968	1	5,713,140	35
Trap net	2,436,868	30	103,705	1	2,540,573	15
Large-mesh gill net	18,270	Tr	834,989	10	853,259	5
Pound net	—	—	232,207	3	232,207	1
Trot line	130,247	2	32,050	Tr	162,297	1
Fyke net	35,275	Tr	—	—	35,275	Tr
Total	8,234,131	—	8,212,960	—	16,447,091	—

[1/] Tr = <0.5%.

Table 4.—Catch (pounds and percentage) and (in parentheses) percentage composition of the catch in 14 seine hauls in Sandusky Bay, April-November 1969.

Category, and species	Estimated total catch		Estimated catch of discarded fish			Estimated weight of landed fish		
	Pounds	%	Pounds	%	% of total catch	Pounds	%	% of total catch
High value								
Walleye	103	Tr[1/]	43	Tr	(42)	60	Tr	(58)
Medium value								
Yellow perch	304	Tr	149	Tr	(49)	155	Tr	(51)
White bass	1,217	1	337	1	(28)	880	2	(72)
Channel catfish	6,454	8	4,460	12	(69)	1,994	4	(31)
Subtotal	7,975	9	4,946	14	(62)	3,029	6	(38)
Low value								
Freshwater drum	48,332	56	13,483	37	(28)	34,849	71	(72)
Carp	8,700	10	810	2	(9)	7,890	16	(91)
Goldfish, carp X goldfish	17,610	21	14,330	39	(81)	3,280	7	(19)
Bullheads	22	Tr	5	Tr	(23)	17	--	(77)
White sucker, redhorse	405	1	232	1	(57)	173	Tr	(43)
Buffalo, quillback	84	Tr	34	Tr	(40)	50	Tr	(60)
Cizzard shad, alewife	2,640	3	2,640	7	(100)	--	--	--
Subtotal	77,793	91	31,534	86	(41)	46,259	94	(59)
Grand total	85,871	--	36,523	--	(43)	49,348	--	(57)

[1/] Tr = <0.5%.

estimated weight for each species and of the estimated weight or percentage of each that was discarded. Errors in estimation were minimized by comparing the tallies of estimated landings with the quantities of boxed fish. As a further check (for trap net catches only), the actual weight of the landed catch of each species recorded in the fish house at the end of the day was compared with the poundage estimated by the observer. The percentage error in the estimated catches ranged from + 10% to —16% for individual trips; however, the total weights of the estimated landings from all 13 series of trap net lifts combined averaged only 4% above the actual landings.

Errors in estimation for seine catches could not be readily checked because the landings from more than one seine haul were often combined and reported as a day's catch. Estimates by observers of the landed and discarded portions, however, were compared with estimates by an experienced foreman to corroborate the poundage estimates for each haul observed.

Haul seine estimates

Catch data were collected at one of the Sandusky Bay seining grounds every two or three weeks from April to November 1969. Estimated weight of a haul seine ranged from a low of 1,372 lb (July 28) to a high of 14,250 lb (June 23). A total catch estimate of 85,871 lb was recorded for the 14 seine hauls, with an average of 6,134 lb (Table 4). Weight of the landed fish averaged 3,525 lb per haul (57% of the total catch) and the discarded portion, 2,609 lb (43%). Some of the discards, however, were fish of high- and medium-value species that were released because they were below legal size. When undersized fish were excluded, the discarded catch that could have been legally kept averaged 2,252 lb per haul—or about 37% of the haul seine catches.

Low-value species made up 91% of the total catch by haul seines—94% of the landed catch and an estimated 86% of the discarded catch (Fig. 6). Freshwater drum made up most of the total catch and landed catch (Table 4). Goldfish and carp also contributed significantly to the total catch. Carp were not as abundant as goldfish in the total catch but contributed a higher portion of the landed fish because of the greater marketability of carp.

Medium-value fishes provided over 9% of the total catch from the bay area—6% of the landed fish and 14% of the estimated weight of dis-

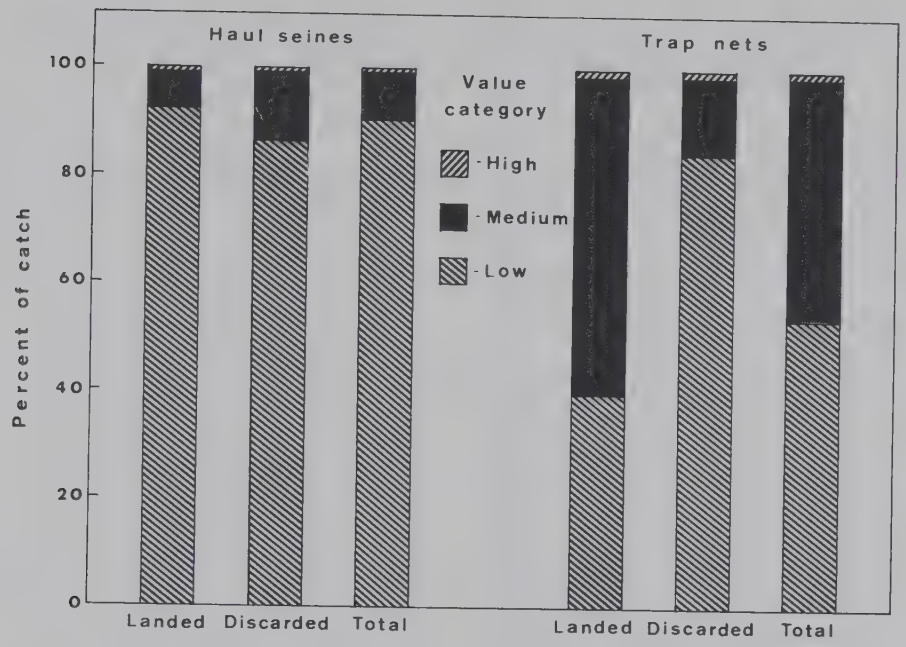

Figure 6.—Percentage contributions of high-, medium-, and low-value fish in the landed, discarded, and total catches estimated for haul seines and trap nets, April-November 1969.

carded fish (all of the discarded fish were below legal size). Channel catfish provided the bulk of the catch of medium-value species. The high-value fishes (represented solely by the walleye) accounted for only 0.1% of the estimated total catch, as well as of the landed and discarded catch. The walleye is not commonly taken in the bay except in early spring during upstream spawning migration to the Sandusky River.

The value of the catch from the 14 seine hauls averaged $167 per haul, calculated from prevailing prices of fish paid to fishermen at the time of capture. The potential worth of the discarded fish averaged $45 per haul if the value for meal or related industrial uses is considered to be 2¢ per pound. The seine fishery, which takes primarily freshwater drum, carp, and goldfish, is in a favorable position to increase income through a greater production of low-value fishes. Even now the haul seiners, with operations requiring little overhead or maintenance of gear and only limited hand labor, occasionally land and market sizable quantities of fish for as little as 2 to 3¢ per pound. Moreover, a majority of the seiners appear interested in increasing their landings of low-value fishes for sale to a steady and dependable buyer, even at this low price.

Trap net estimates

Tallies of the estimated catches were recorded on 13 trips (226 trap net lifts) to the fishing grounds in the open waters of the western basin from April to November 1969. The number of trap nets checked per trip ranged from 10 to 35 and averaged 17.4. The number of nets lifted on a given day usually depended on the catch of higher value species, *i.e.*, the higher the catch of high- and medium-value fish, the smaller the number of nets lifted. In essence, it amounted to a self-imposed catch quota on the more select species to prevent a market glut that causes lower prices for succeeding catches.

The total catch estimates from a single day's operation ranged from a high of 15,615 lb (May 28) to a low of 2,700 lb (September 3). Catches were usually largest in the spring. Estimates of the catches totaled 102,189 lb for the 13 trips, or an average of 7,860 lb per trip (Table 5).

Table 5.—Catch (pounds and percentage) and (in parentheses) percentage composition of the catch from 226 trap net lifts in U.S. waters of the western basin, April-November 1969.

Category, and species	Estimated weight of total catch		Estimated weight of discarded fish			Estimated weight of landed fish			Actual weight of landings	
	Pounds	%	Pounds	%	% of total catch	Pounds	%	% of total catch	Pounds	%
High value										
Walleye	748	1	226	1	(30)	522	1	(70)	498	1
Medium value										
Yellow perch	33,665	33	2,514	8	(7)	31,151	44	(93)	31,177	46
White bass	9,759	10	1,318	4	(14)	8,441	12	(86)	9,288	14
Channel catfish	3,232	3	936	3	(29)	2,296	3	(71)	2,252	3
Subtotal	46,656	46	4,768	15	(10)	41,888	59	(90)	42,717	63
Low value										
Freshwater drum	39,408	39	13,712	43	(35)	25,696	36	(65)	21,589	32
Carp	6,447	6	4,870	15	(76)	1,577	2	(24)	1,578	2
Goldfish, carp X goldfish	4,567	4	4,567	14	(100)	—	—	—	—	—
Bullheads	367	Tr[1]	69	Tr	(19)	298	Tr	(81)	365	1
White sucker, redhorse	965	1	719	2	(75)	246	Tr	(25)	547	1
Buffalo, quillback	566	1	340	1	(60)	226	Tr	(40)	267	Tr
Gizzard shad, alewife	2,465	2	2,465	8	(100)	—	—	—	—	—
Subtotal	54,785	54	26,742	84	(49)	28,043	40	(51)	24,346	36
Grand total	102,189	—	31,736	—	(31)	70,453	—	(69)	67,561	—

[1] Tr = < 0.5%.

Table 6.—Projection of the commercial yield from haul seines and trap nets in U.S. waters of the western basin in 1969.

Category, and species	Haul seines			Trap nets			Combined gear	
	Actual production		Projected production	Actual production		Projected production	Actual production	Projected production
	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	Pounds
High value								
Walleye	21,194	Tr[1]	21,194	158,296	7	158,296	179,490	179,490
Whitefish	—	—	—	488	Tr	488	488	488
Subtotal	21,194	Tr	21,194	158,784	7	158,784	179,978	179,978
Medium value								
Yellow perch	73,080	1	73,080	952,453	39	952,453	1,025,533	1,025,533
White bass	465,368	8	465,368	631,326	26	631,326	1,096,694	1,096,694
Channel catfish	459,705	8	459,705	127,981	5	127,981	587,686	587,686
Subtotal	998,153	18	998,153	1,711,760	70	1,711,760	2,709,913	2,709,913
Low value								
Freshwater drum	1,613,841	29	2,238,397	277,945	11	426,368	1,891,786	2,664,765
Carp	2,800,998	50	3,089,500	164,032	7	670,563	2,965,030	3,760,063
Goldfish, carp X goldfish	98,912	2	531,059	—	—	92,232	98,912	623,291
Bullheads	21,466	Tr	27,777	11,904	1	14,666	33,370	42,443
White sucker, redhorse	32,997	1	77,246	78,581	3	308,258	111,578	385,504
Buffalo, quillback	21,594	Tr	36,278	33,638	1	84,230	55,232	120,508
Gizzard shad, alewife	—	—	261,941	—	—	49,780	—	311,721
Others[2]	17	Tr	17	224	Tr	224	241	241
Subtotal	4,589,825	82	6,262,215	566,324	23	1,646,321	5,156,149	7,908,536
Grand total	5,609,172	—	7,281,562	2,436,868	—	3,516,865	8,046,040	10,798,427

[1] Tr = <0.5%.
[2] Others: rainbow smelt, mooneye, burbot, American eel, bowfin.

Actual landings averaged 5,197 lb per trip, or about two-thirds of the total catch. This figure compares favorably with my estimate of 5,419 lb landed per trip, or 69% of the catch. Discarded fish averaged 2,441 lb per trip or 31% of the catch and consisted of 2,057 lb of low-value fishes and 384 lb of undersized fish of high or medium value.

Low-value species accounted for 54% of the estimated total catch (by weight), 36% of the landed catch (as compared with my estimate of 40%), and 84% of the discarded fish. Freshwater drum were dominant in both the total catch and the discarded portion. Medium-value fish accounted for about 46% of the estimated total catch, 59% of the estimated weight of landed fish, and 15% of the discards. Yellow perch, second in abundance among individual species in the estimated total catch, ranked first in the landed catch. White bass were also significant in the total and in the landed catch. High-value species (walleye) accounted for only 0.7% of the total catch, and for this same percentage of landings and discards.

The sale value of the catch from a day's lift of trap nets averaged $547, based on prevailing prices paid at the time the catches were made. At 2¢ per pound, the potential worth of the discarded catch averaged $41 per day. Athough little interest has been shown among trap netters in increasing the landings of species that are worth only 2 or 3¢ per pound, conversations with these fishermen indicated that they would willingly land the low-value fishes for 5 to 7¢ per pound minimum. Even though sizable quantities of the low-value fishes are usually available, it is unlikely that the trap netters will increase their landings under existing conditions.

POTENTIAL CATCHES

The commercial yield of high- and medium-value species could not have been increased in 1969 without an increase in fishing effort, since all fish of legal size were kept. An increase in production could have been realized only by keeping the discarded low-value fishes. In estimating the potential harvest of the unused fish in western Lake Erie by haul seines and trap nets in 1969, I assumed that the relation between the landed and discarded fish in the observed catches was generally characteristic of the total U.S. fishery for the western basin.

Estimates of the landed and the discarded fish from the catches of the 14 seine hauls and 226 trap net lifts were used to determine the potential commercial harvest in the western basin in 1969. A total of about 188,000 pounds of fish were taken in the seine hauls and trap net lifts observed. The projected catch was computed for each species (except gizzard shad and goldfish—see below) by first determining a numerical factor from the ratio of landed fish to the total catch in the hauls and lifts observed. The 1969 commercial production for each species was then multiplied by its corresponding factor to give the projected production for that particular species. For example, since 13,712 of the 39,408 lb of freshwater drum taken by trap nets were discarded (Table 5), the estimated landed catch of 25,696 lb of freshwater drum would have been increased 1.534 times if the discards had been kept. In turn, the U.S. commercial catch of 277,945 lb of freshwater drum by trap nets from the western basin in 1969 was projected ($\times$ 1.534) to a production of 426,368 lb (Table 6).

Computations for two species—gizzard shad and goldfish—differed from that described above. Gizzard shad were not kept by haul seiners and neither gizzard shad nor goldfish by trap net fishermen. To compute the catches of these species, I determined the ratios of discarded weight of both species to the landed catch of all low-value species in the hauls and lifts observed (Tables 4 and 5). The 1969 commercial yield for all low-value species was then multiplied by the percentages of discarded specimens of both species to estimate their potential yield by the designated gear. For example, over 2,640 lb of gizzard shad were caught and released from the observed seine hauls—or about 6% of the 46,259 lb of low-value species that were landed. This percentage, multiplied by the 4,589,825 lb of commercially produced low-value fishes in 1969, provided a potential yield of 261,941 lb of gizzard shad that could have been harvested by haul seines in 1969. This method was also used to determine the potential yield of gizzard shad and goldfish in trap nets in 1969. Incidental catches of the miscellaneous low-value species

were not projected because their potential yields would be insignificant (see Table 6).

Haul seine catches

The U.S. haul seine production in the western basin in 1969 totaled 5.6 million lb. However, if all low-value fish had been kept, the total would have been 7.3 million lb (Table 6). Most of the increased yield would have consisted of freshwater drum, goldfish, carp, and gizzard shad.

A possible discrepancy arises in estimates because it is not known how continuous landings of discarded fish affect the catches in subsequent hauls. Continuous cropping would probably reduce the population faster than it could be replaced by movement from unfished areas and by growth and recruitment. However, large quantities of these low-value species were sometimes present at the seining grounds a few days after sizable landings had been made. In fact, seine hauling was frequently discontinued because of an overabundance of low-value fish, which forced temporary gluts in an unstable market. In general, I believe that the poundages of the discarded catches from haul seines represented only a small portion of the vast populations of low-value fishes that were lightly exploited.

Trap net catches

In 1969, trap net yield from the U.S. portion of the western basin totaled 2.4 million lb. The low-value fishes could have contributed another 1.1 million lb if the discards had been kept, to yield a total trap net production of 3.5 million lb (Table 6). Most of the estimated increase in production would have consisted of carp, suckers, freshwater drum, and goldfish. Although the projected yield of the low-value fishes by trap nets was 4.6 million lb less than for haul seines, it appears that the potential catch of these species by trap nets could (with a moderate increase in fishing effort) equal and possibly exceed that from haul seines without endangering the resource.

Combined catches

The combined production for haul seines and trap nets in U.S. waters of the western basin in 1969 totaled over 8.0 million lb, and was worth about $990,000 to the fishermen on the basis of the value of the total U.S. commercial catch from Lake Erie in 1969. The nearly 2.8 million lb of discarded low-value fishes, if landed at a price of 2¢ per pound, would have had an added cash value of $55,000 to the fishermen. Although the value of the discarded portion seems small, this additional poundage represents a 34% increase in yield over the 1969 production in U.S. waters of the western basin. Furthermore, the harvest of low-value species by haul seines and trap nets could be increased considerably and probably sustained.

CONCLUSIONS

Although no specific information on levels of abundance of low-value fishes in Lake Erie is available, the harvest of these species could be substantially increased over the projected 1969 total of 7.9 million lb, with little or no loss in production from the other State and Provincial waters of the lake.

The biological capacity of Lake Erie to produce fish appears to be as high as ever although the trend toward dominance of low-value species in the lake, particularly in the western basin, seems likely to continue in the foreseeable future. A recent study of the numerous problems contributing to the decline of the commercial fishery in the Ohio waters of Lake Erie emphasized the need for industry to adjust its operations to a changing resource base if it is to survive (Lewis, 1966). Change offers the industry a great challenge and also its greatest opportunity. It appears that an increased commercial harvest of low-value species can be compatible with, and even benefit, the sport fishery. Sound fishery management in western Lake Erie may even require a greater commercial exploitation of these low-value fishes.

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LITERATURE CITED

APPLEGATE, VERNON C., and HARRY D. VAN METER.
1970. A brief history of commercial fishing in Lake Erie. U.S. Dep. Int., Bur. Commer. Fish., Fish. Leafl. 630, 28 p.

BAILEY, R. M. (CHAIRMAN)
1970. A list of common and scientific names of fishes from the United States and Canada. Am. Fish. Soc., Spec. Publ. 6, 149 p.

BALDWIN, NORMAN S., and ROBERT W. SAALFELD.
1962. [plus supplement, 1970]. Commercial fish production in the Great Lakes 1867-1960 [Supplement 1961-68]. Great Lakes Fish. Comm. Tech. Rep. No. 3:166 p.

CHAPMAN, CHARLES R.
1955. Sandusky Bay report. Ohio Div. Wildl. Spec. Rep., 84 p.

JONES, WALTER G.
1960. Fishery resources for animal food. U.S. Dep. Int., Bur. Commer. Fish., Fish. Leafl. 501, 22 p.

LANGLOIS, THOMAS H.
1954. The western end of Lake Erie and its ecology. J. W. Edwards Publ., Ann Arbor, Mich., xx + 479 p.

LEWIS, DONALD W.
1966. The decline of the Lake Erie commercial fishing industry in Ohio. Ph.D. Thesis, Ohio State Univ., Columbus, Ohio, ix + 212 p.

PREMETZ, ERNIE D.
1956. Development of markets for underutilized Lake Erie fish—progress report. Commer. Fish. Rev. 18(11):1-7.

GPO 987-214

6 Oil pollution on Wake Island from the tanker *R. C. Stoner*. By Rginald M. Gooding. May 1971, iii + 12 pp., 8 figs., 2 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

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8 Length-weight relations of haddock from commercial landings in New England, 1931-55. By Bradford E. Brown and Richard C. Hennemuth. August 1971, v + 13 pp., 16 fig., 6 tables, 10 appendix A tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

9 A hydrographic survey of the Galveston Bay system, Texas 1963-66. By E. J. Pullen, W. L. Trent, and G. B. Adams. October 1971, v + 13 pp., 15 figs., 12 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 30 cents.

0 Annotated bibliography on the fishing industry and biology of the blue crab, *Callinectes sapidus*. By Marlin E. Tagatz and Ann Bowman Hall. August 1971, 94 pp. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price $1.00.

Use of threadfin shad, *Dorosoma petenense*, as live bait during experimental pole-and-line fishing for skipjack tuna, *Katsuwonus pelamis*, in Hawaii. By Robert T. B. Iversen. August 1971, iii + 10 pp., 3 figs., 7 tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 25 cents.

2 Atlantic menhaden *Brevoortia tyrannus* resource and fishery—analysis of decline. By Kenneth A. Henry. August 1971, v + 32 pp., 40 figs., 5 appendix figs., 3 tables, 2 appendix tables. For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 - Price 45 cents.

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